Research Article

Physical activity and life satisfaction among individuals with spinal cord injury: Exploring loneliness as a possible mediator

Nicholas Santino[1], Victoria Larocca[1], Sander L. Hitzig [2,3,4], Sara J.T. Guilcher [2,5,6,7], B. Catharine Craven [2,6,8,9], Rebecca L. Bassett-Gunter[1]

[1]School of Kinesiology & Health Science, Faculty of Health, York University, Toronto, Canada, [2]Rehabilitation Sciences Institute, Faculty of Medicine, University of Toronto, Toronto, Canada, [3]St. John's Rehab Research Program, Sunnybrook Research Institute, Sunnybrook Health Sciences Centre, Toronto, Canada, [4]Department of Occupational Science & Occupational Therapy, Faculty of Medicine, University of Toronto, Toronto, Canada, [5]Leslie Dan Faculty of Pharmacy, University of Toronto, Toronto, Canada, [6]Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto, Canada, [7]MAP Centre for Urban Health Solutions, St. Michael's Hospital, Toronto, Canada, [8]Neural Engineering & Therapeutics Team, Toronto Rehabilitation Institute, University Health Network, Toronto, Canada, [9]Division of Physiatry, Department of Medicine, University of Toronto, Toronto, Canada

Context: There has been no known research investigating the association between leisure time physical activity (LTPA), loneliness, and life satisfaction among people with spinal cord injury or dysfunction (SCI/D). The relationship between these constructs is worthy of consideration given the positive health impacts of LTPA, the negative health impacts of loneliness, and heightened negative effects of loneliness on life satisfaction for individuals with SCI/D.
Objectives: To examine the relationship between LTPA and loneliness, and examine loneliness as a possible mediator of the relationship between LTPA and life satisfaction among individuals with SCI/D.
Design and Participants: Community dwelling individuals with SCI/D ($N = 170$) participated in a telephone-based survey as part of a larger project.
Measures: LTPA (i.e. The Leisure Time Physical Activity Questionnaire-SCI, UCLA Loneliness Scale-3, and the Life Satisfaction Questionnaire-11 were administered to the participants.
Results: Significant bivariate relationships were observed between LTPA and life satisfaction ($r = .18$, $P = .02$), LTPA and loneliness ($r = -.15$, $P = .045$), and loneliness and life satisfaction ($r = -.69$, $P < .001$). Mediation analyses suggest that loneliness significantly mediated the relationship between LTPA and life satisfaction (indirect effect = .003, 95% bootstrap CI = .0004 to .0062, CSI = .113).
Conclusion: This was the first study to show evidence of a negative association between LTPA and loneliness among people with SCI/D, and to establish a conceptual model for understanding the potential mediating role of loneliness in the relationship between LTPA and life satisfaction among people with SCI/D.

Keywords: Leisure time physical activity, Disability, Perceived social isolation, Loneliness, Spinal cord injury

Following spinal cord injury or dysfunction (SCI/D), many individuals experience a loss in motor and/or sensory function, as well as impairments in bladder, bowel, sexual, and autonomic function.[1] People with SCI/D also experience associated secondary health conditions, such as spasticity, urinary tract infections, musculoskeletal and/or neuropathic pain, pressure injuries, and cardiac problems.[2] Environmental and social factors such as poor accessibility, high rates of unemployment, and limited social participation further contribute to poor psychosocial outcomes post-SCI/D.[3–5] Due to these physical and social challenges, people with SCI/D are at greater risk of experiencing low self-esteem,[6] depressive and anxiety disorders, and feelings of helplessness, compared to the general

Correspondence to: Rebecca L. Bassett-Gunter, School of Kinesiology & Health Science, York University, 4700 Keele Street, Toronto, Ontario, Canada M3J 1P3, Ph: 416-736-2100 Ext. 22072. Email: rgunter@yorku.ca

DOI 10.1080/10790268.2020.1754651

population.[7] It is therefore not surprising that many people with SCI/D face difficulties that negatively impact their wellbeing and life satisfaction.[8]

Several studies have shown that physical activity participation is associated with improved physical health and subjective wellbeing post SCI/D.[9–12] In particular, there have been efforts to promote leisure time physical activity (LTPA; physical activity that one chooses to do during their free time),[13] post-SCI/D.[14] Based on the Canadian Physical Activity Guidelines for Adults with SCI/D, adults with SCI/D should participate in moderate to vigorous LTPA for 20–30 min at least two times per week for both aerobic and strength exercises.[14] LTPA has been significantly associated with lower levels of pain, fatigue and depression, and higher levels of social support and life satisfaction post SCI/D.[15,16]

While there is a lack of evidence in SCI/D research, LTPA has also been shown to address issues of loneliness across different populations (e.g. inactive adult students and the elderly).[17,18] Loneliness can be defined as a person's subjective perception of lacking *quality* social engagement.[19,20] Loneliness is of particular concern in the SCI/D population, as individuals with SCI/D tend to experience higher levels of loneliness than the general population, likely due to the combination of the aforementioned physical, environmental, and social challenges accompanied with SCI/D.[1–8,21] Further, loneliness is a critical issue to investigate as it has been shown to negatively relate to health, wellbeing, and life satisfaction among various populations (e.g. cardiovascular disease, depression, and suicidal behavior).[22–26]

Despite the negative health impacts of loneliness, there have only been a handful of studies examining loneliness and life satisfaction among people with SCI/D. e.g.[6,21] People with SCI/D often experience heightened negative effects of loneliness on their life satisfaction.[6,21] To our knowledge, there has been no known studies that have investigated the association between LTPA, loneliness, and life satisfaction among people with SCI/D. Given that LTPA holds a number of benefits to health and wellbeing post SCI/D, and that LTPA has shown to address loneliness in other groups, the objectives of the present study were to: (a) assess the relationship between LTPA and loneliness among people with SCI/D, and (b) examine loneliness as a possible mediator of the relationship between LTPA and life satisfaction among individuals with SCI/D. Although the association between LTPA and life satisfaction is well established within other populations,[27] there is still a lack of understanding of the pathways through which (i.e. why) LTPA leads to improved life satisfaction. Since LTPA often provides opportunities for social participation, we hypothesized that loneliness may serve as an important mediator in this relationship. As well, it was hypothesized that loneliness will be negatively related to LTPA and in turn, life satisfaction will be negatively related to loneliness.

Method

Design and participants

Data were collected as part of a larger project examining issues of social isolation and health in people with SCI/D.[28] Participants were former patients of the Toronto Rehabilitation Institute's Brain and Spinal Cord Rehabilitation Program (Lyndhurst Centre, Toronto, Ontario, Canada). The Rick Hansen Institute Spinal Cord Injury Registry and the Jousse Long-term Follow-up Database were used to identify potential participants. The Rick Hansen Institute Spinal Cord Injury Registry is a national Canadian registry that collects data on various elements (e.g. socio-demographic factors, medical history, injury details, and neurologic impairment) pertaining to people who have sustained a traumatic SCI/D.[29] The Jousse Long-term Follow-up Database is a research platform that tracks the long-term health and quality of life outcomes for aging Ontarians with SCI/D.[30,31] Eligible participants included English-speaking adults (18 years or older) with traumatic or non-traumatic SCI/D, who were at least two years post injury and community dwelling. Individuals with self-reported hearing, speech and/or cognitive impairments were excluded from the study. A total of 170 adults with traumatic or non-traumatic SCI/D were included in the final sample.

The study protocol was approved by the institutional Research Ethics Boards of the University Health Network – Toronto Rehabilitation Institute and York University. All applicable institutional and governmental regulations regarding the ethical use of human volunteers were followed. Informed consent was obtained from participants through direct telephone contact by trained interviewers.

Measures

Sociodemographic and clinical characteristics

Data were collected regarding each participant's sex, age, employment, level of education, marital status, living situation (i.e. number of people in household), number of years post injury, etiology (i.e. traumatic or nontraumatic), level of injury, and impairment severity (i.e. complete or incomplete). These data were collected through self-report via the A.T. Jousse Long-term

Follow-up Questionnaire, which is a non-standardized survey used to gather data related to socio-demographics, impairment and health status post SCI/D.[31] The first three digits of each participant's postal code was used to identify whether participants were living in a rural or urban environment. Internet ownership was also assessed.

Leisure time physical activity

LTPA was measured using the Leisure Time Physical Activity Questionnaire for People with Spinal Cord Injury (LTPAQ-SCI), which is a tool designed to determine the frequency and intensity of LTPA among people with SCI/D.[32,33] Participants were asked to recall the number of days, over the past week, that they participated in mild, moderate, and heavy LTPA. Additionally, participants were asked to recall how many minutes they spent participating at each intensity. The LTPAQ-SCI has been previously used in the SCI/D population and has demonstrated validity and reliability (ρ = .27 to .54 with PARA-SCI and all ICC values for each subscale >.60).[33] LTPA was calculated as total average minutes per week at moderate and heavy intensities. This operationalization of LTPA was chosen as it allows for consistency with the Canadian Physical Activity Guidelines for Adults with SCI/D,[14] and thus likely to be related to health outcomes (e.g. life satisfaction).

Loneliness

Loneliness was measured using the 3-item UCLA Loneliness Scale.[34,35] The The UCLA Loneliness Scale-3 is designed to assess how often an individual feels a lack of companionship, being left out, and being isolated from others. Each item is reported on a three-point Likert-type scale, ranging from 1 (i.e. "hardly ever") to 3 (i.e. "often"). This particular version of the UCLA Loneliness Scale was chosen as it was created for telephone surveys, has exhibited high internal consistency (Cronbach alpha = .81), and has demonstrated validity and reliability for community-dwelling individuals with SCI/D.[8,34] Items were summed, resulting in a range of scores from 3 to 9, with higher scores representing higher degrees of loneliness.

Life satisfaction

Life satisfaction was measured using the 11-item Life Satisfaction Questionnaire (LiSat-11).[36] The LiSat-11 includes a single item that assesses global life satisfaction and 10 items that assess domain-specific life satisfaction. All items are on a six-point Likert-type scale ranging from a minimum of 1 (i.e. "very dissatisfied") to 6 (i.e. "very satisfied"). This questionnaire has high internal consistency (Cronbach alpha = ~.85), and has demonstrated validity and reliability within the SCI/D population.[37] An overall life satisfaction variable was calculated by summation of all 11 items, resulting in scores ranging from 11 to 66, with higher scores representing a higher degree of life satisfaction.

Procedure

Participants (n = 170) received an introductory letter via post mail and were subsequently contacted by telephone. After providing informed consent, each individual participated in one telephone interview conducted by trained interviewers. Each interview lasted approximately 45 min. During the interview, socio-demographics, LTPA, loneliness, and life satisfaction were assessed through self-report. Participants received a $10.00 gift card.

Statistical analysis

Descriptive statistics and frequencies were calculated to characterize the sample. Pearson's correlations of the main variables of interest (i.e. LTPA, loneliness, and life satisfaction) were then calculated to justify the mediation model. A critical alpha level of .05 was considered for statistical significance at the bivariate level. Finally, a mediation analysis using Process Macro (version 3.4)[38] was calculated to determine if loneliness was a potential mediator of the relationship between LTPA and life satisfaction. Due to the exploratory nature of this study, all sociodemographic and clinical characteristics were entered into the mediation analysis as possible covariates. A 10,000 bootstrap was used and a confidence interval of 95% was considered. Data were analyzed using SPSS (v25; IBM SPSS Statistics c/o IBM Corp. Armonk, NY, USA).

Results

Of the 170 participants, the majority were male (n = 136, 80%), over 55 years old (n = 116, 68.2%), had a traumatic injury (n = 149, 87.6%), incomplete tetraplegia (n = 58, 34.1%), and had been living with SCI/D for 10 years or more (n = 122, 71.8%; see Table 1). The majority of participants were also unemployed or retired (n = 125, 73.5%), had at least a post-secondary education (n = 129, 75.9%), were married or in a common law relationship (n = 102, 60.0%), were living with others (n = 128, 75.3%), were living in an urban setting (n = 136, 80.0%), and had internet access (n = 165, 97.1%).

The average minutes per week of moderate and heavy LTPA was 255.25 (SD = 457.59). The average loneliness score was 4.93 (SD = 1.87), with 31.2% of the sample scoring a 6 or higher, indicating that approximately

Table 1 Descriptive statistics of sample ($N = 170$).

Variable	*n*	%	Mean	SD
LTPA[1] (mins/wk.)			255.25	457.59
Loneliness			4.93	1.87
Life Satisfaction			44.29	11.99
Years Post Injury				
Less Than 10 Years	48	28.2		
10 Years or More	122	71.8		
Etiology				
Traumatic	149	87.6		
Non-Traumatic	21	12.3		
Impairment Severity				
Incomplete Tetraplegia	58	34.1		
Complete Tetraplegia	30	17.7		
Incomplete Paraplegia	40	23.5		
Complete Paraplegia	40	23.5		
No Response	2	1.2		
Sex				
Male	136	80.0		
Female	34	20.0		
Age				
Under 55 Years Old	54	31.8		
Over 55 Years Old	116	68.2		
Employment				
Employed/Student/Volunteer	125	73.5		
Unemployed/Retired	45	26.5		
Education				
High School or Less	41	24.1		
Beyond High School	129	75.9		
Marital Status				
Married/Common Law	102	60.0		
Single/Divorced/Separated/ Widowed	68	40.0		
Living Situation				
Living Alone	42	24.7		
Living with Others	128	75.3		
Geographic Location				
Urban	136	80.0		
Rural	34	20.0		
Internet Access				
Yes	165	97.1		
No	4	2.4		

Note: [1]LTPA: Leisure time physical activity.

one third of the sample felt lonely at least "some of the time." The mean life satisfaction score was 44.29 (SD = 11.99).

Significant bivariate correlations were found between LTPA and life satisfaction ($r = .18$, P = .02), LTPA and loneliness ($r = –.15$, P = .05), and loneliness and life satisfaction ($r = –.69$, P < .001) (Table 2).

The mediation analysis is presented in Fig. 1. Results of the mediation analysis were significant, demonstrating that loneliness significantly mediated the relationship between LTPA and life satisfaction (indirect effect = .003, 95% bootstrap CI = .0004 to .0062, CSI = .113). Living situation was found to be the only significant covariate in the mediation model ($\beta = –4.71$, P = .03). Within the mediation model, loneliness significantly and negatively related to LTPA ($\beta = –.007$, P = .04) and life satisfaction significantly and negatively related to loneliness ($\beta = –4.29$, P < .001).

Table 2 Pearson *r* correlations.

	1	2	3
1. LTPA	1.00		
2. Loneliness	–.15*	1.00	
3. Life Satisfaction	.18*	–.69**	1.00

Note: [1]LTPA: Leisure time physical activity, *P ≤ .05, **P ≤ .01

Discussion

The purpose of this study was to examine the relationship between LTPA and loneliness among people with SCI/D, and examine loneliness as a possible mediator of the relationship between LTPA and life satisfaction. As hypothesized, LTPA and loneliness were negatively related. Although the relationship between LTPA participation and loneliness has not previously been examined in the SCI/D population, our findings are consistent with correlational, longitudinal, and intervention research among other populations (e.g. inactive adult students and the elderly).[27] Although these data are cross-sectional and correlational, the results speak to the importance of understanding LTPA as not only a method to improve physical capabilities, but also the psychosocial wellbeing of individuals with SCI/D. Future research should consider creating longitudinal or experimental designs in order to prove causation and gain a deeper understanding of the pathways through which (i.e. why) LTPA participation may reduce feelings of loneliness.

This study further expands on previous literature through the examination of loneliness as a possible mediator of the relationship between LTPA and life satisfaction. e.g.[27] As hypothesized, loneliness mediated the relationship between LTPA and life satisfaction, suggesting that higher levels of LTPA were related to lower levels of loneliness, which in turn were related to higher levels of life satisfaction. Thus, the positive relationship between LTPA and life satisfaction could be partially explained by the effects of LTPA on loneliness for some individuals with SCI/D. This finding is consistent with previous research which has examined other mediators of the relationship between physical activity and wellbeing outcomes. For example, affective constructs such as self-concept and self-esteem have been identified as possible mediators in the relationship between physical activity and wellbeing outcomes similar to life satisfaction. e.g.[39–41]

Results from the mediation analysis also align with self-determination theory.[42] Within self-determination theory, the basic psychological needs theory reasons

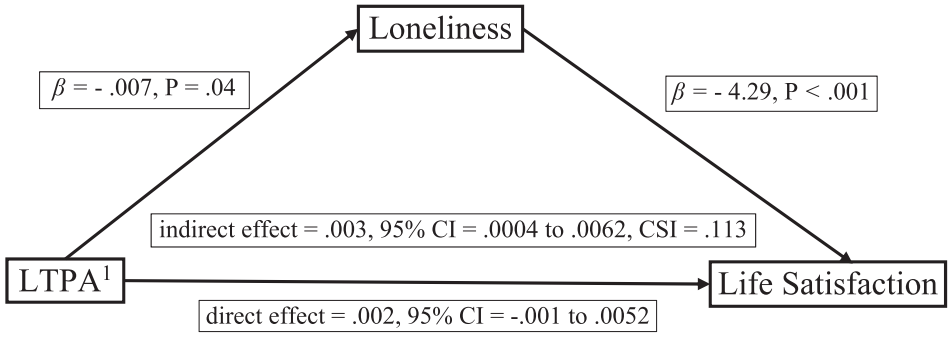

Figure 1 Mediation analysis.
Note: [1]LTPA: Leisure time physical activity.

that autonomy, competence, and relatedness are universal and basic psychological needs that predict optimal functioning and wellbeing when supported by one's environment.[43] The need for relatedness reflects the need to feel *quality connection* with individuals in one's social network.[44] Contrary to feelings of relatedness, feelings of loneliness are negative feelings that occur when one feels they are *lacking quality connection* with others. As such, experiences that foster relatedness are likely to reduce feelings of loneliness. As well, LTPA environments are known to promote and maintain wellbeing across a variety of settings and populations. e.g.[45–48] For example, participating in LTPA has been associated with higher levels of basic need satisfaction across all three needs, including relatedness.[45] LTPA environments can foster and support feelings of relatedness (and possibly autonomy and competence), which can reduce feelings of loneliness, and ultimately improve life satisfaction. As such, future research should begin to examine experiential aspects of physical activity (i.e. autonomy, belonging, challenge, engagement, meaning, mastery).[49] Investigating these experiential aspects of participation as mediators can provide a greater explanation of the many potential pathways through which physical activity is related to positive outcomes.[49,50]

In the current study, living situation was the only significant covariate in the mediation model. Individuals who lived alone had significantly lower life satisfaction than those who lived with at least one other person. This finding is consistent with previous research that focuses on adults 55 years of age or older (68.2% of the current sample was 55 years of age or older),[51] while other research has not been able to find this significant association when examining broader age ranges.[52] A possible explanation for this finding is that, for older populations, social interactions at home may assist in developing a social network that encourages individuals to participate more in society and thus having a greater life satisfaction than individuals who live alone. This has been shown through the positive associations of social interaction with physical and mental health for individuals aged 50 and above.[53–55] Future research should consider further examining why living alone may relate to a lower life satisfaction at certain ages or life course. For example, exploring who individuals are living with (e.g. friend or spouse), why they live with them (e.g. emotional, informational, tangible or intangible support), the quality of their relationship (e.g. the extent of support), and how those and other variables may change over time can help create a better understanding of these mixed results.

Although the current study advances the understanding of why LTPA may improve the life satisfaction of people with SCI/D, it is not without limitations. As such, although statistical significance was found, the relevance per individual may have differed if the sample size was smaller. First, LTPA was measured based on frequency (i.e. average minutes per week) and intensity (i.e. moderate and/or vigorous). Ideally, asking participants to report additional context surrounding their LTPA (i.e. social aspects of LTPA and with whom they engaged in LTPA) would have given a more detailed picture of the many potential factors involved in this tripartite relationship. Second, loneliness and life satisfaction are subjective and therefore having solely objective measures limits the ability of the study to generate a detailed understanding of the context in which these variables interact. A mixed-methods (i.e. quantitative and qualitative) design would have been a more rigorous approach to understand the relationship between these variables.[56] Third, the study design was cross-sectional, and as such, causation cannot be established. Rather, the study establishes a conceptual basis for future work to examine loneliness as a causal mediator of the relationship between LTPA and life satisfaction through longitudinal and experimental designs.

Future research could also examine additional moderators and mediators to gain a deeper understanding of the complex relationship between LTPA and life satisfaction. For example, personal (e.g. self-esteem and self-concept) and environmental constructs (e.g. quality of LTPA participation and independent versus social LTPA) would be interesting factors to consider as possible moderators and/or mediators of the relationship between LTPA and life satisfaction. Despite these limitations, this is the first known study to demonstrate a significant negative relationship between LTPA and loneliness among people living with SCI/D.

Conclusion

This was the first study to show evidence of a negative association between PA and loneliness among people with SCI/D, and to establish a conceptual model for understanding the potential mediating role of loneliness in the relationship between PA and life satisfaction in this population. Among individuals with SCI/D, there is a negative relationship between LTPA and loneliness. Further, loneliness may play a mediating role in the relationship between LTPA participation and life satisfaction. Continued research in this area using longitudinal and mixed-methods designs can inform the creation and modification of existing LTPA programs (e.g. screening and identifying lonely individuals to encourage LTPA participation, and identifying which individuals in the program may form close interpersonal bonds and group them together during LTPA) to optimize positive outcomes and maximize life satisfaction among people with SCI/D.

Disclaimer statements

Contributors None.

Funding This work was supported by Canadian Institutes of Health Research; Craig H. Neilsen Foundation (US) under the Psychosocial Research Pilot Grant [grant number 364897].

Conflict of interest As the Principal Investigator on this project, [Sander L. Hitzig] received salary support from the Craig H. Neilsen Foundation. [Sara J.T. Guilcher] is supported by the Canadian Institutes of Health Research under the Embedded Clinician Scientist Salary Award in Transitions in Care working with Health Quality Ontario. No other potential conflicts of interest were reported by the authors.

ORCID

Sander L. Hitzig http://orcid.org/0000-0002-9139-9250

Sara J.T. Guilcher http://orcid.org/0000-0002-9552-9139

B. Catharine Craven http://orcid.org/0000-0001-8234-6803

References

1 Noonan VK, Fingas M, Farry A, Baxter D, Singh A, Fehlings MG, *et al.* The incidence and prevalence of spinal cord injury in Canada: a national perspective. Neuroepidemiology 2012;38:219–26.
2 Craven C, Hitzig SL, Mittmann N. Impact of impairment and secondary health conditions on health preference among Canadians with chronic spinal cord injury. J Spinal Cord Med 2012;35:361–70.
3 Ottomanelli L, Lind L. Review of critical factors related to employment after spinal cord injury: implications for research and vocational services. J Spinal Cord Med 2009;32:503–31.
4 Price P, Stephenson S, Krantz L, Ward K. Beyond my front door: the occupational and social participation of adults with spinal cord injury. OTJR 2011;31:81–8.
5 Tsai IH, Graves DE, Chan W, Darkoh C, Lee MS, Pompeii LA. Environmental barriers and social participation in individuals with spinal cord injury. Rehabil Psychol 2017;62:36–44.
6 Tzonichaki I, Kleftaras G. Paraplegia from spinal cord injury: self-esteem, loneliness, and life satisfaction. OTJR 2002;22:96–103.
7 Craig A, Tran Y, Middleton J. Psychological morbidity and spinal cord injury: a systematic review. Spinal Cord 2009;47:108–14.
8 Robinson-Whelen S, Taylor HB, Feltz M, Whelen M. Loneliness among people with spinal cord injury: exploring the psychometric properties of the 3-item loneliness scale. Arch Phys Med Rehabil 2016;97:1728–34.
9 Crane DA, Hoffman JM, Reyes MR. Benefits of an exercise wellness program after spinal cord injury. J Spinal Cord Med 2017;40:154–8.
10 Martin Ginis KA, Jetha A, Mack DE, Hetz S. Physical activity and subjective well-being among people with spinal cord injury: a meta-analysis. Spinal Cord 2010;48:65–72.
11 Sliwinski MM, Akselrad G, Alla V, Buan V, Kaemmerlen E. Community exercise programming and its potential influence on quality of life and functional reach for individuals with spinal cord injury. J Spinal Cord Med 2018. doi:10.1080/10790268.2018.1543104.
12 Wolfe DL, McIntyre A, Ravenek K, Martin Ginis KA, Latimer AE, Eng JJ, *et al.* Physical activity and SCI. In: Eng JJ, Teasell RW, Miller WC, Wolfe DL, Townson AF, Hsieh JTC, Connolly SJ, Mehta S, Sakakibara BM, (ed.) Spinal Cord Injury Rehabilitation Evidence. Version 4.0. Vancouver (BC): SCIRE Project; 2012. p. 1–25.
13 Bouchard C, Shephard RJ. Physical activity, fitness, and health: the model and key concepts. In: Bouchard C, Shephard RJ, Stephens T, (ed.) Physical Activity, Fitness, and Health: International Proceedings and Consensus Statement. Champaign (IL): Human Kinetics; 1994. p. 77–88.
14 Martin Ginis KA, van der Scheer JW, Latimer-Cheung AE, Barrow A, Bourne C, Carruthers P, *et al.* Evidence-based scientific exercise guidelines for adults with spinal cord injury: an update and a new guideline. Spinal Cord 2018;54:308–21.
15 Taran S, Conti J, Francois R, Latimer-Cheung AE, Noreau L, Sweet SN. Leisure time physical activity, perception of impact of pain and life satisfaction after spinal cord injury. Ann Phys Rehabil Med 2018;61:273–5.
16 Tawashy AE, Eng JJ, Lin KH, Tang PF, Hung C. Physical activity is related to lower levels of pain, fatigue and depression in individuals with spinal-cord injury: a correlational study. Spinal Cord 2009;47:301–6.
17 Dowd AJ, Schmader T, Sylvester BD, Jung ME, Zumbo BD, Martin LJ, *et al.* Effects of social belonging and task framing on exercise cognitions and behavior. J Sport Exerc Psychol 2014;36:80–92.
18 Toepoel V. Ageing, leisure, and social connectedness: how could leisure help reduce social isolation of older people? Soc Indic Res 2013;113:355–72.

19 de Jong Gierveld J. A review of loneliness: concept and definitions, determinants and consequences. Rev Clin Gerontol 1998;8:73–80.
20 Perlman D, Peplau LA. Toward a social psychology of loneliness. In: Duck SW, Gilmour R, (ed.) Personal Relationships. Personal Relationships in Disorder. Vol. 3. London, UK: Academic Press; 1981. p. 31–56.
21 Tough H, Brinkhof MW, Siegrist J, Fekete C. The impact of loneliness and relationship quality on life satisfaction: a longitudinal dyadic analysis in persons with physical disabilities and their partner. J Psychosom Res 2018;119:61–7.
22 Goodwin R, Cook O, Yung Y. Loneliness and life satisfaction among three cultural groups. Pers Relatsh 2001;8:225–30.
23 Hombrados-Mendieta I, Garcia-Martin MA, Gomez-Jacinto L. The relationship between social support, loneliness, and subjective well-being in a Spanish sample from a multidimensional perspective. Soc Indic Res. 2013;114:1013–34.
24 Houghton S, Hattie J, Carroll A, Wood L, Baffour B. It hurts to be lonely! Loneliness and positive mental wellbeing in Australian rural and urban adolescents. J Psychol Counsell School 2016;26:55–67.
25 Tu Y, Zhang S. Loneliness and subjective well-being among Chinese undergraduates: the mediating role of self-efficacy. Soc Indic Res 2015;124:963–80.
26 Yanguas J, Pinazo-Henandis S, Tarazona-Santabalbina FJ. The complexity of loneliness. Acta Biomed 2018;89:302–14.
27 Pels F, Kleinert J. Loneliness and physical activity: a systematic review. Int Rev Sport Exerc Psychol 2016;9:231–60.
28 Guilcher SJT, Craven BC, Bassett-Gunter RL, Cimino RS, Hitzig SL. An examination of objective social disconnectedness and perceived social isolation among persons with spinal cord injury/dysfunction: a descriptive cross-sectional study. Disabil Rehabil 2019. doi:10.1080/09638288.2019.1616328.
29 Noonan VK, Kwon BK, Soril L, Fehlings MG, Hurlbert RJ, Townson A. RHSCIR network. The Rick Hansen spinal cord injury registry (RHSCIR): a national patient-registry. Spinal Cord 2012;50:22–7.
30 Hitzig SL, Tonack M, Campbell KA, McGillivray CF, Boschen KA, Richards K, *et al.* Secondary health complications in an aging Canadian spinal cord injury sample. Am J Phys Med Rehabil 2008;87:545–55.
31 Tonack M, Hitzig SL, Craven BC, Campbell KA, Boschen KA, McGillivray CF. Predicting life satisfaction after spinal cord injury in a Canadian sample. Spinal Cord 2008;46:380–5.
32 Martin Ginis KA, Latimer AE. Leisure time physical activity questionnaire for people with spinal cord injury (LTPAQ-SCI). SCI Action Canada 2007. [accessed 2019 Apr 10]. Available from: https://sciactioncanada.ca/research-publications.cfm.
33 Martin Ginis KA, Phang SH, Latimer AE, Arbour-Nicitopoulos KP. Reliability and validity tests of the leisure time physical activity questionnaire for people with spinal cord injury. Arch Phys Med Rehabil 2012;93:677–82.
34 Hughes ME, Waite LJ, Hawkley LC, Cacioppo JT. A short scale for measuring loneliness in large surveys: results from two population-based studies. Res Aging 2004;26:655–72.
35 Russell D, Peplau LA, Cutrona CE. The revised UCLA loneliness scale: concurrent and discriminant validity evidence. J Pers Soc Psychol 1980;39:472–80.
36 Fugl-meyer AR, Meling R, Fugl-meyer KS. Life satisfaction in 18- to 64-year-old Swedes: in relation to gender, age, partner and immigrant status. J Rehabil Med 2002;34:239–46.
37 Post MW, van Leeuwen CM, van Koppenhagen CF, de Groot S. Validity of the life satisfaction questions, the life satisfaction questionnaire, and the satisfaction with life scale in persons with spinal cord injury. Arch Phys Med Rehabil 2012;93:1832–7.
38 Hayes AF. Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach. 2nd ed. New York (NY): The Guilford Press; 2018.
39 Joseph RP, Royse KE, Benitez TJ, Pekmezi DW. Physical activity and quality of life among university students: exploring self-efficacy, self-esteem, and affect as potential mediators. Qual Life Res 2014;23:659–67.
40 Rejeski WJ, Shelton B, Miller M, Dunn AL, King AC, Sallis JF. The activity Counseling Trail research group. mediators of increased physical activity and change in subjective well-being: results from the activity counseling trial (ACT). J Health Psychol 2001;6:159–68.
41 Silvestre TG, Landa SU. Women, physical activity, and quality of life: self-concept as a mediator. Span J Psychol 2016;19:1–9.
42 Ryan MR, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 2000;55:68–78.
43 Ryan RM, Deci EL. Self-determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness. New York (NY): Guilford Press; 2017.
44 Deci EL, Ryan RM. Intrinsic Motivation and Self-Determination in Human Behavior. New York (NY): Plenum; 1985.
45 Davies MJ, Coleman L, Babkes Stellino M. The relationship between basic psychological need satisfaction, behavioral regulation, and participation in CrossFit. J Sport Behavior 2016;39:239–54.
46 Edmunds J, Ntoumanis N, Duda JL. Testing a self-determination theory based teaching style in the exercise domain. Eur J Soc Psychol 2000;38:375–88.
47 Gunnell KE, Crocker PRE, Mack DE, Wilson PM, Zumbo BD. Goal contents, motivation, psychological need satisfaction, well-being and physical activity: a test of self-determination theory over 6 months. Psychol Sport Exerc 2014;15:19–29.
48 Ryan MR, Williams CG, Patrick H, Deci EL. Self-determination theory and physical activity: the dynamics of motivation in development and wellness. Hellenic J Psychol 2009;6:107–24.
49 Martin Ginis KA, Evans MB, Mortenson WB, Noreau L. Broadening the conceptualization of participation of persons with physical disabilities: a configurative review and recommendations. Arch Phys Med Rehabil 2017;98:395–402.
50 Caron JG, Martin Ginis KA, Rocchi M, Sweet SN. Development of the measure of experiential aspects of participation for people with physical disabilities. Arch Phys Med Rehabil 2019;100:67–77.
51 Lim LL, Kua EH. Living alone, loneliness, and psychological well-being of older persons in Singapore. Curr Gerontol Geriatr 2011. doi:10.1155/2011/673181.
52 Mellor D, Stokes M, Firth L, Hayashi Y, Cummins R. Need for belonging, relationship satisfaction, loneliness, and life satisfaction. Pers Indiv Differ 2008;45:213–8.
53 Ohrnberger J, Fichera E, Sutton M. The relationship between physical and mental health: a mediation analysis. Soc Sci Med 2017;195:42–9.
54 Umberson D, Montez JK. Social relationships and health: a flashpoint for health policy. J Health Soc Behav 2010;51:554–66.
55 Umberson D, Crosnow R, Reczek C. Social relationships and health behaviors across life course. Anny Rev Sociol 2010;36:139–57.
56 Hansen M, O'Brien K, Meckler G, Chang AM, Guise JM. Understanding the value of mixed methods research: the children's safety initiative-emergency medical services. Emerg Med J 2016;33:489–94.